Atmospheric GHG measurements onboard Voluntary Observing Ships - approaches for improved atmospheric sampling

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RINGO | Readiness of ICOS

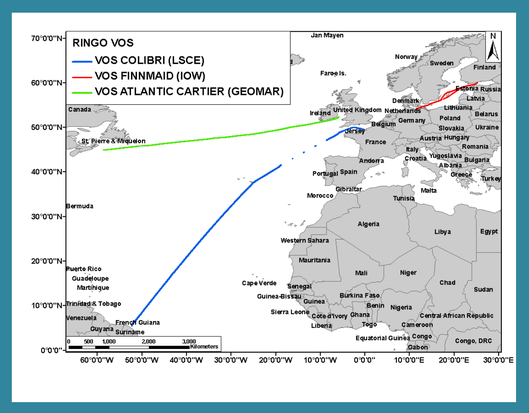
Atmospheric measurements onboard VOS lines

Rationale

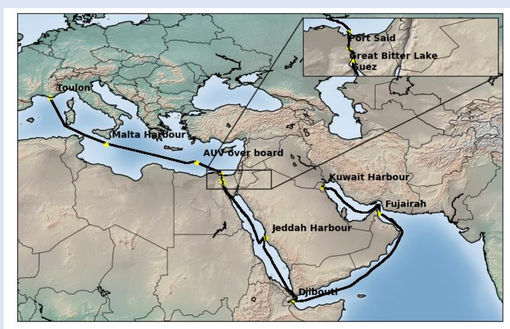
- High quality data from air over the ocean are rare
- ICOS VOS lines (monitoring seawater pCO_2 etc.) are already instrumented and maintained, usually run on pre-defined lines and provide a unique, platform-dependent spatiotemporal coverage
- High potential value for inverse modelling approaches

Approach

- Using the different installations on three VOS lines as a pilot study within RINGO as proof of concept;
- pilot study realizing different concepts and addressing different individual challenges
- Strong collaboration between OTC (Ocean Thematic Centre) and ATC (Atmospheric Thematic Centre)



France-Guyane VOS line



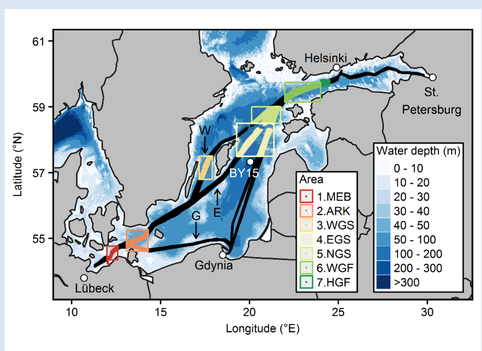
Approach

- Set up of an automated and high precision integrated atmospheric measurement system (Picarro G2401, multi-position valve, calibration/target cylinders set, for CO_2, CH_4, CO measurements and complementary GPS,meteorological sensors)?

Validation of the instrumental setup:

- The full experimental set up was sucessfully tested during the Aqaba campaign in summer 2017 across the mediterranean and around the Arabian Peninsula (see above map).

Baltic VOS line

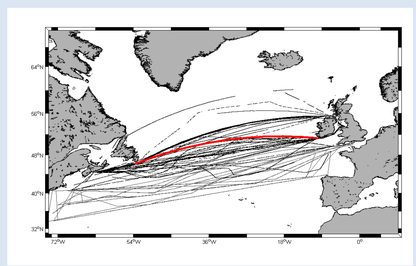


- Implementation of an independent atmospheric measurement system matching ATC requirements
- Set-up design should allow easy mobilization (change of carrier)

Rationale for the line:

- Short repetition time (3 days for trip Lübeck – Helsinki and back)
- Bridging contintental and maritime air-masses
- Surrounded by ICOS stations on land

North Atlantic VOS line



- Using existing seawater pCO_2 measuring system which is installed in the ship's engine room (CO_2 sensor is a Licor 7000 or Picarro G2131-i)
- Drawing air through long tubing from top of the ship to the measuring system
- Inlet filter (Coke bottle filled with filter mat) improved precision by a factor of 2
- **Precision of ±0.10 ppm** (using Licor 7000) was reached
- 2017 the ship was taken out of service. Installation onboard the replacement to be completed in September 2018

Central facilities (CAL/ATC)

ICOS CAL (calibration lab):

- Providing sets of calibrated real air standard gases
  - to link VOS observations to WMO - GAW calibration scales
  - To perform ongoing QC onboard by regular target gas measurement
- Providing material to collect grab samples in parallel to in-situ measurements
- Performing flask sample measurements as external quality control

ATC (Atmospheric Thematic Centre):

- Processing of G2401 on board ship is operational
- AQABA campaign data have been used as test case for implementation
- Implementation of GPS data and Picarro G2131i sensor in progress

Challenges

- Amount of standard gases: bracketing atmosphere and ocean (200 – 900 ppm CO_2) can easily reach 7 gas bottles
- Data ingestion from different sensors
- External validation of atmospheric data
- The optimal suction point is at the bow of the ship. Due to safety restrictions it is hard to access.

Outlook

- Using inverse models to estimate the surplus of atmospheric data from marine boundary layer
- The strong links between OTC and ATC will be further improved
- **Technological handbook and assessment report on implementation of ATC-conform atmospheric measurements of CO_2 onboard VOS lines**

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